February 6, 1894.

Sir W. H. Flower, K.C.B., LL.D., F.R.S., President, in the Chair.

The Secretary read the following report on the additions to the Society's Menagerie during the month of January 1894.

The total number of registered additions to the Society's Menagerie during the month of January was 78, of which 30 were by presentation, 2 by birth, 34 by purchase, 4 by exchange, and 8 were received on deposit. The total number of departures during the same period, by death and removals, was 100.

Amongst these attention should be specially called to a young male Ounce, or Snow-Leopard (*Felis uncia*), obtained by purchase from Mr. J. S. Mackay, of Dunbar House, Kullu, Punjab, being the animal described in the letter from that gentleman read on the 7th of December last (see P. Z. S. 1893, p. 692).

Mr. Sclater called attention to a fine mounted specimen of the River-hog of Madagascar (*Potamochœrus edwardsi*) from the Tring Museum, lent for exhibition by the Hon. W. Rothschild, F.Z.S., and remarked that three distinct species of this well-marked Ethiopian genus (see Scl. P. Z. S. 1860, p. 301) of Suidæ were now known:—

1. *Potamochœrus africanus*, which is believed to range from the Cape throughout Eastern Africa up to Abyssinia, where it appears as *Nyctochœrus hassama* of Heuglin (Ant. u. Büff. Suppl. p. 7; et Fitz. Sitzungsb. Ak. Wiss. Wien, Bd. liv. Abth. i. p. 586).

2. *Potamochœrus penicillatus* of West Africa (well figured in Wolf and Sclater's Zoological Sketches, vol. i. pl. xxix.), which, as well as *P. africanus*, has been frequently exhibited alive in our Gardens (see List of Animals, 1883, p. 183).

3. *Potamochœrus edwardsi* (see P. Z. S. 1875, p. 64, pl. xii.) from Madagascar (at once known by its black under surface), of which a specimen is now before us.

Mr. J. T. Last, by whom the specimen exhibited had been obtained, had kindly furnished the following field-notes on this species:—

"Of the Wild Boars in Madagascar there are two, perhaps three, species. The largest (*Potamochœrus edwardsi*) is said to inhabit the upland forest regions; while a smaller species lives near the coast. I was told by Béfanátriki, an Antinosi king, that there is also another species, much shorter in body than the two mentioned above and of a white colour. I suggested to him that it might be a white hog run wild, but he insisted that it is not a 'kúsu' (domesticated pig) but a 'lambu,' 'lámbunála' (a wild boar). I cannot vouch for the truth of his statement because I have not seen the animal, but the king evidently believed in the information he was giving me.

"It is very difficult to say much about the habits and manners of the wild boars, the fact being that they are seldom seen alive by persons who are competent to observe them. I was nearly five years in Madagascar, and only once did I meet, as it were by accident, with a boar on his rambles; this was one morning about 7 o'clock, on some hills about 2000 feet or more above the sea-level, in the north part of Madagascar. Once again I met with it in South Central Madagascar, but this happened in the course of hunting.

"It must not be concluded that because wild boars are so seldom seen they are few in number—such is far from being the case. It is scarcely possible to go into any village, especially all along the west side of Madagascar, and not hear the natives complain of the havoc made by these animals. In the gardens, in the open country, and in the forest the wild boar makes himself busy, turning up the ground wherever he goes.

"During my stay in the Mújangá district I paid a visit to Katsépi, about lat. 15° 45′ S. I was here, travelling and roaming about all over the country, for several days—over bare hills, through dense forests, and across as rough a kind of country, full of holes and caves, as I have ever seen. The country everywhere showed that the wild boar existed there in great numbers—in fact, in no other part of Madagascar have I met with such abundant proofs of its prevalence; and yet all the while I was roaming about in this district I did not see one. The reason for this is that the boar is never about in the daytime. He has but one enemy—that is, man—and he has sufficient instinct to know that his enemy may come upon him at any time or place if he roams about in the daytime. He therefore, very wisely, sleeps all day, and in the evening, when all is quiet, starts out on his feeding-expeditions, and probably to meet his friends.

"Whilst out feeding there is but little that comes amiss to the wild boar; he may be said to be almost omnivorous. If he enters a garden he makes the greatest havoc possible; he can clear off any amount of young green rice and all sorts of garden-produce. The natives have the greatest difficulty in keeping him away. They make strong fences around their gardens, and often watch night after night to get a shot at their troublesome visitor; but he is generally more cunning and more patient than the man. At last, perhaps, the man, for some reason or other, will absent himself from the gardens for one night; he goes to look at them in the morning, but he is too late, the boar has had his revel and the gardens are spoilt. These remarks are simply the substance of a conversation I had with some men working for me, who live at Bára-máhamáî, in about lat. 13° 40′ S., and who had had their gardens destroyed in this manner.

"The wild boar can generally find something to eat in whatever kind of country he may be in. On the plains and open country (where there are no gardens to attack) he will turn up the ground in all directions, searching for various kinds of tubers, and I daresay he disposes of all grubs, insects, and other forms of animal-life which may happen to come in his way. In the forest he meets with an abundance of food—ripe fruit fallen from the trees, yam-like bulbs and tubers, the babu, valá, súza, and many others in plenty, just under the surface of the ground. In turning these out he may frequently come across the nests of mice, rats, or one of the many species of Tandrec. All these he is able to dispose of, and even snakes, it is said, do not come amiss to him.

"The wild boar does not leave his lair during the day unless he is disturbed by hunters or their dogs, and even then he is not in a hurry to move until he is close pressed. When undisturbed, he passes the day in sleep and in the evening resumes his search for food again.

"In almost every village of importance one or more of the natives know something of forestry. They keep a number of dogs, and with them spend a great part of their time in the bush. Here the dogs are trained in running down birds, especially the Crested Ibis (*Lophotibis cristata*) and the Striped Partridge (*Margaroperdix striata*), in treeing the Guinea-fowl (*Numida tiarata*), in searching the ground to find some of the various species of Tandrec, or, most important work of all, in hunting the wild boar.

"I do not think the natives are in the habit of hunting the wild boar simply from love of sport, they are generally too lazy to go hunting for the pleasure it should give; rather, when they do hunt, it is either for the sake of getting some animal food or else to rid themselves of a night visitor, which has been making a too-free use of the garden-produce.

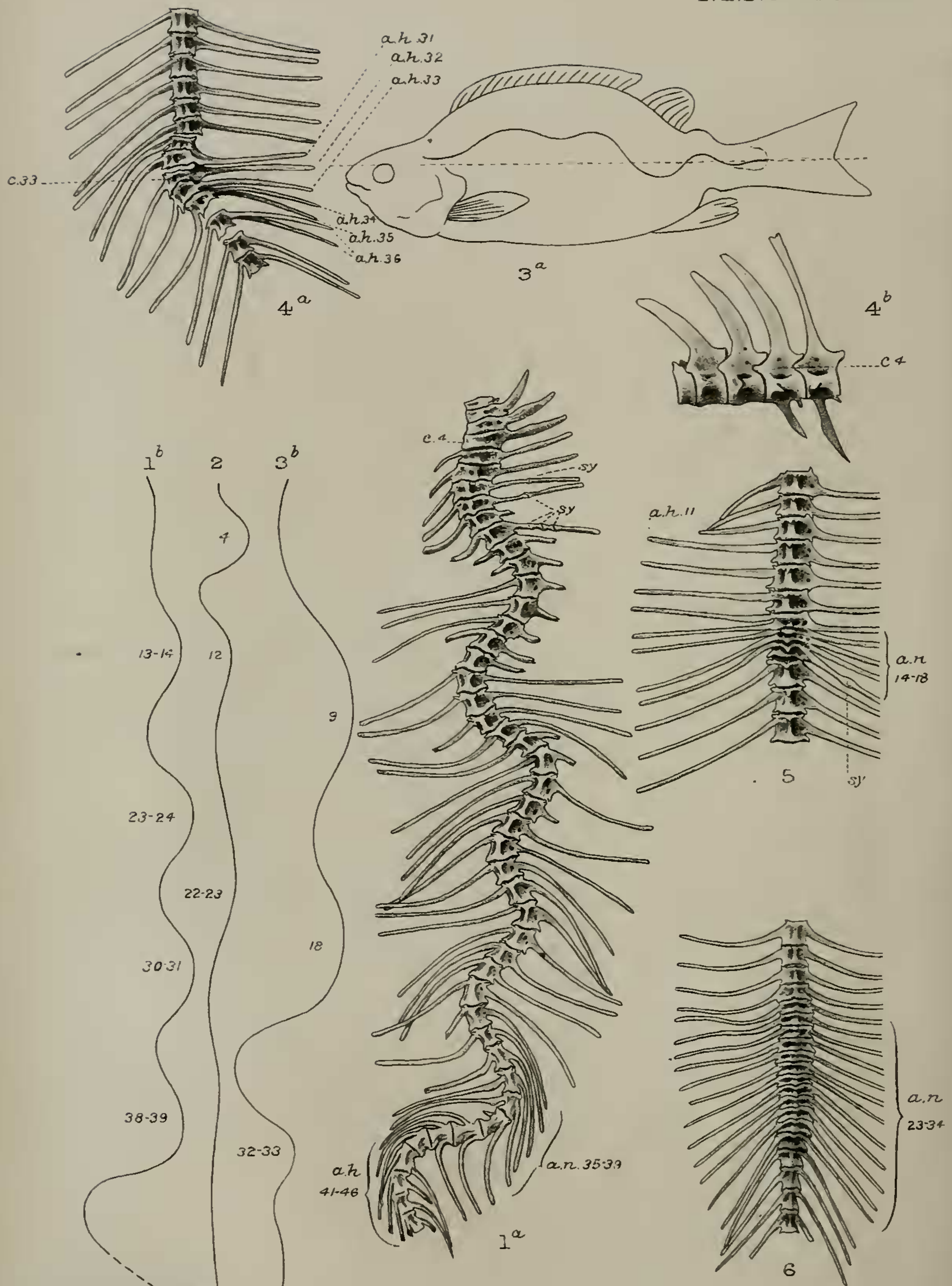
"In speaking of the range of the wild boar in Madagascar, I think I am correct in saying that there is no part of the island where it is not to be met with in numbers more or less. What I have already said shows that it is to be found on the elevated inland country as well as on the low-lying plains; that it makes its home in forest, bush, or holes, wherever it is convenient.

"These few remarks which I have been able to give concerning the wild boar are, I believe, applicable to that animal in all parts of Madagascar; but I must state that my own personal observations were confined to the west side and to the south central parts of the island."

Mr. Sclater exhibited a stuffed specimen of the White-billed Great Northern Diver (*Colymbus adamsi*) from Norway, fully adult; which had been forwarded to him by Prof. R. Collett, of Christiania, F.M.Z.S., in order to be figured in the 'Ibis,' and made remarks on the distribution of the species and on its interest as occasionally occurring on the British coast, as first recorded by him in 1859 (P. Z. S. 1859, p. 206)[1].

The following papers were read:—

[1] See also Seebohm, 'Zoologist,' 1885, p. 144; and Saunders, 'Manual of British Birds,' p. 695.



G. S. Newth Photo & C. Stewart del.
M. P. Parker lith.

West, Newman imp.

Synostosis & Curvature of the Spine in Fishes.

1. On Synostosis and Curvature of the Spine in Fishes, with especial reference to the Sole. By G. B. Howes, F.L.S., F.Z.S., Assistant Professor of Zoology, R. Coll. Sci. Lond.

[Received January 16, 1894.]

(Plate XII.)

A short time ago my pupil Mr. W. L. S. Loat placed in my hands for examination a backbone of the Sole (Plate XII. figs. 1 *a* and 1 *b*) which presents the unique abnormality of a quinque-recurrent curvature, such as I believe has never before been recorded. On turning to that rich storehouse of teratological material, the Royal College of Surgeons' Museum, for specimens which might throw light upon this extraordinary backbone, I have been so fortunate as to meet with facts which, while they show the Sole's vertebral column to be liable to a wide range of structural aberration, give us a clue to at any rate the determining cause of that form of curvature herein dealt with (*cf. infra*, p. 100)[1]. By a fortunate coincidence, two malformed backbones of this fish (figs. 4 *a* and 5) had been quite recently presented to that Institution by Prof. Bland Sutton; and to that gentleman, together with the Council of the College and my ever willing friend Prof. Chas. Stewart, I tender my thanks for permission to examine and report upon their specimens.

Mr. Loat's specimen was that of an old fish having an estimated length of from 9 to 10 inches, and 47 of its vertebræ were preserved, the terminal ones (? 3 in number) having been lost. The backbone of the normal Sole is straight, except for a feeble arching of its anterior 14–16 vertebræ[2]. In this example (fig. 1 *a*) it was, as already stated, thrown into a series of fixed sinuosities, five in number as reckoned by their vertices, a marked depression preceding the terminal one. All the vertebræ but the anterior 3 or 4 and that lying at the base of the second dip were more or less displaced in the vertical plane, and the minor details of the disturbance may be more readily gleaned from the accompaning figure (which is an accurate copy of a photograph) than expressed in words. There can be no doubt that the aberration was congenital, for the vertebral bodies (which were fully formed and independent throughout) conform in many cases to sections of a circle, owing to the adaptive modification of their articular faces.

More interesting, perhaps, than this is the condition of the arches, as is at once evident from the fact of the practical absence of any marked sinuosity of the contour described by their free ends. To

[1] "The causes producing congenital curvature of the spine are unknown," R. Coll. Surgeons' Descr. Cat. of the Teratological Series, 1893, p. 94.

[2] *Cf.* Cunningham, 'A Treatise an the Common Sole.' Plymouth: Marine Biol. Assoc., 1890.

take for example the hæmal ones, the 13th measures in total length 1 inch, the 18th $\frac{3}{4}$ of an inch, and the 23rd $1\frac{1}{16}$ inch. In the normal individual possessed of a straight backbone, the corresponding elements exhibit a progressive increase in length—here they have undergone an adaptive variation, whereby an approximately normal and regular contour of the creature's body was unquestionably maintained; and the extent to which, as the result of pure adaptation, this had been carried is most significant in the flexion to the utmost of certain of the posterior hæmals and neurals depicted in the sketch (*a.h.* 41–46, *a.n.* 35–39).

On comparison of as much of this skeleton as is preserved with the corresponding parts of a normal individual, an increase in vertical diameter proportionate to diminution in length becomes at once apparent. The total length of the vertebral column as it lies flexed is 6 inches, its actual length measured along the curves $7\frac{5}{8}$ inches, and its longest outstanding process, hæmal or neural, does not exceed $1\frac{1}{8}$ inch. I am in possession of one normal skeleton of identical proportions in which arches 25 to 28 are longer; and it would appear therefore more than likely that skeletal growth in the vertical plane was under rather than over the average in this remarkable individual.

Beyond this, the specimen bears no marked peculiarities not apparent in the accompanying figure. There was no co-ossification of parts, but the neural spines of vertebræ 7, 8, and 10 bear synostotic enlargements (*sy.*) indicative of preceding fracture. There was no lateral displacement of either the vertebral bodies or their associated arches, beyond a feeble irregularity of certain of the hæmal arches, not improbably due to shrinkage in drying.

The nearest approach to a similar condition to this which I have been able to find is that of a Perch in the Hunterian Series of the Royal College of Surgeons (figs. 3 *a* and 3 *b*). That, however, shows but three marked sinuosities, and the third of these, in contradistinction to that of the Sole, is accompanied by a displacement of the tail to the animal's left side[1]. Salient points of agreement with the Sole are, however, forthcoming in the otherwise non-sinuous contour of the animal's body, and in the fact that the shallowest spinal sinuosity is most nearly median and the deepest one posterior in position. The full number of vertebræ (viz. 42)[2] are present, and the detailed differences between the curvature of this animal's backbone and that of the Sole are sufficiently expressed in the accompanying illustrations (*cf.* figs. 1 *b* and 3 *b*).

As with the Sole, the approximation of the ends of the spinal column consequent on the curvature was accompanied by an increase in vertical diameter of the body, though to a greater extent than in that animal—for, while the greatest vertical diameter of a normal Perch (excluding its dorsal fin) is rather more than $\frac{1}{4}$th its

[1] There is in the College of Surgeons' collection an undissected Perch having a precisely similar curvature (No. 361 of the Catalogue cited). *Cf.* Postscript, p. 100.

[2] *Cf.* Günther, Introd. to the Study of Fishes, p. 53.

total length, in this specimen it is nearly $\frac{1}{3}$rd of that [1]. The hæmal and neural arches of this specimen are normal, except for a marked flexion forwards of the neurals numbering 20 to 24.

Another instance of curvature of the spine in the Sole, for which I am indebted to the Royal College of Surgeons, is that traced in fig. 2. This case differs most conspicuously from both the foregoing in the acuteness of the first two sinuosities, and in the fact that at each vertex there is a slight displacement to the left side, which in all probability involved the body as a whole. Except for the first eight neurals, which are very aberrant, the arches had so adapted themselves to the situation as to have maintained the normal regularity of contour of their extremities; and the only lesser detail worthy of remark here is the presence of synostotic enlargements [2] on the neural spines 9, 10, and 11.

48 vertebræ in all are present.

Synostosis of the vertebræ of fishes has been recorded by Erdl and Stannius [3]. While it is most generally regarded as confined to the opposite extremities of the spine, Owen has pointed out [4] that in *Pleuronectidæ* " a kind of sacrum is formed by such bony union of the bodies of the first two of the caudal series." Examination of a series of Pleuronectid skeletons will easily convince anyone that this is an inconstant feature.

The most important monograph on the subject is to be found among Hyrtl's classical contributions to the Vienna Denkschriften [5]. In a short preliminary communication which immediately preceded the aforesaid monograph, Hyrtl remarked [6] that "the number of co-ossified vertebræ is 2 to 6," and that " this synostosis takes place more frequently in the tail than in the trunk"—while, commenting on the probable ill effects of the malformation, he naïvely points out that diminution in flexibility is, at any rate in some cases, " obviated by the fact that the confluent vertebræ are not larger than the non-confluent ones, their length being so much reduced that the five coalesced vertebræ are not longer than one and a slight fraction of a non-coalesced one." In his second monograph he has described certain conditions to which this fascinating argument will not apply, for example that of a Codfish in which the six co-ossified vertebræ occupy a greater area than the two which precede them.

One of the aforementioned specimens which Prof. Sutton has

[1] Length $8\frac{3}{4}$ in., greatest vertical diameter $2\frac{5}{8}$ in.

[2] I have in no instance observed these on the hæmal side.

[3] By Stannius in *Amia* (Handb. d. Zootomie, Aufl. 2, Th. i. p. 21). His record of the fusion of "intercalary with true vertebræ" becomes one of synostosis of vertebral bodies, from Schmidt's discovery (Zeitschr. wiss. Zool. Bd. liv. p. 748) of the truly vertebral nature of the so-called inter-centra of this animal.

[4] Comp. Anat. of Vertebrates, vol. i. p. 42.

[5] " Ueb. Wirbelsynostosen und Wirbelsuturen bei Fischen," Wien. Denkschr. xx. 1862, pp. 95–110.

[6] Nat. Hist. Review, vol. ii. 1862, pp. 103–104.

recently deposited in the College of Surgeons' Museum is that of a Sole (of which vertebræ nos. 8 to 21 are unfortunately alone preserved) in which the co-ossification of the five vertebræ numbering 14 to 18 is closely approximate in condition to Hyrtl's first recorded examples. The co-ossified vertebræ (fig. 5) collectively occupy an area of less than two normal vertebræ; and in correlation with the compression which the former have undergone, their related arches, being approximated at their bases, form a series of radiating outgrowths. Except that the 18th neural spine bears a conspicuous synostotic enlargement (*sy.*), with signs of previous dismemberment, the remaining parts are normal.

More interesting than this specimen is that numbered 500 in the College of Surgeons' Catalogue (fig. 6). The vertebræ between and including the 6th and the 38th are in this case preserved, and special interest centres in the 12 postanal, which number 23 to 34 inclusive, and are very closely compressed although not co-ossified.

Except for the co-ossification of the right half of the 14th hæmal arch with the left half of the 15th, and an accompanying absence of the right half of the latter and total independence of the two halves of the former, the remaining vertebræ are in every respect normal; and as these correspond in detail with their numerical homologues in the normal column, there is little room for the supposition, which might at first present itself, that the compressed vertebræ are perhaps intercalary in nature.

The twelve compressed vertebræ are very dense, and the area which they collectively occupy is equivalent to that of the seven immediately in front of them. As compared with the specimen last described, they are in a much less compressed condition; and the feeble approximation of their arches amply testifies to this assertion. The most instructive feature of this specimen is tho circumferential increase of the bodies of the compressed vertebræ over those of the rest of the column; and, in adaptation to the conditions imposed, the faces of the vertebræ (nos. 22 and 35) that immediately abut against the compressed series are sympathetically modified. At first sight these compressed vertebræ would appear to be in a condition of retarded growth, and to consist, bulk for bulk, of less osseous matter than a corresponding number of normal ones. When placed in the scale, however, they were found to be the heavier of the two[1]. It is clear from this that mere compression of bony structures over a given bodily area need not necessarily be accompanied by a diminution in bone-forming activity; and in the case under consideration the surplus material appears to have largely encroached upon the periosteal and intervertebral tissues. The arches remained free and did not participate in the excess.

The remaining specimen to which I would direct attention is

[1] ·660 grm. as compared with ·575 for the twelve next in order of succession anteriorly.

the second of the two furnished by Prof. Sutton. The entire column consists of 48 vertebræ, and its most noteworthy feature is a single flexion involving the 30th to the 35th of the series. These are so modified (fig. 4 *a*) as to form an arch, of which the 33rd (*c.* 33) is the keystone. The ventral compression of the 33rd vertebra of this specimen is more marked than that of any similarly modified vertebra with which I am familiar; and in accordance with this and the corresponding adaptive shelving of the anterior faces of the 34th and 35th, the succeeding vertebræ must in life have been disposed at a sharp angle to those in front of them.

It is characteristic of the specimens which I have thus far described that where sinuosity occurs synostosis is uneffected, but inasmuch as in the example now under consideration vertebræ nos. 31 and 32 (*cf.* fig.) are partially united, that so far bridges over the gap between the sinuous and compressed types. This union is seen to be the outcome of an extension of the right base of the 31st hæmal arch (*a.h.* 31), that structure, as it were, having welded together the two vertebræ. In correlation with this there have arisen a series of displacements involving only the right side, rendering it at first sight apparent that the 35th and 36th hæmal arches are double. This is in reality not so, for detailed analysis shows that the right half of the 32nd hæmal arch had become shifted back and confluent with the body of the 33rd vertebra, while the corresponding halves of the 33rd and 34th arches had become similarly shifted and co-ossified with the vertebræ (34th and 35th) next in order of succession behind. The two halves of the 36th hæmal had, in sympathy, but insignificantly united beneath the hæmal canal, and the right half of the 35th had entirely disappeared.

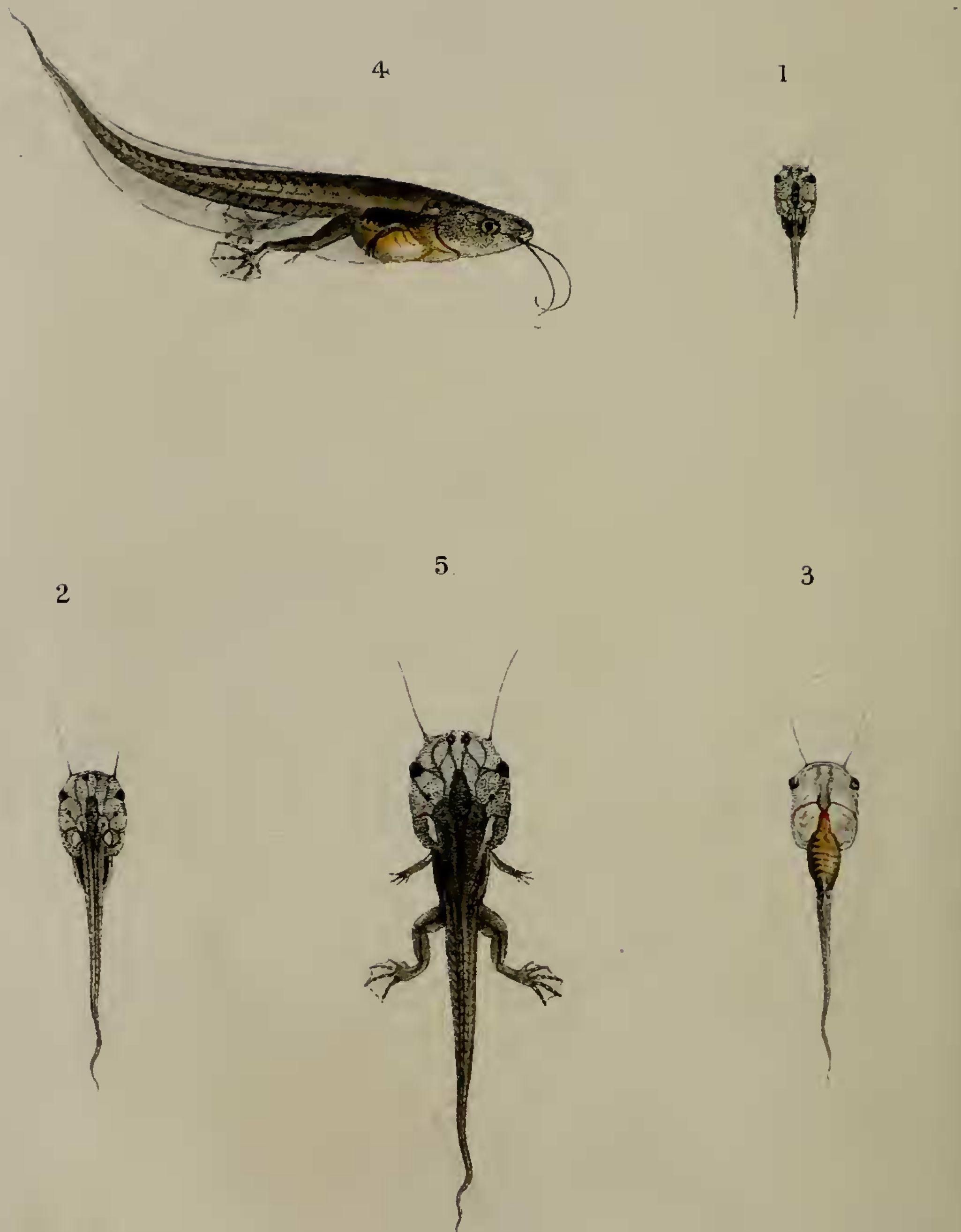
The arches of the remaining vertebræ of this specimen are normal; but those of the distorted region present, in addition to the features already described, an irregular lateral disposition, those of the 31st and 32nd especially being so modified as to conform in end view to the limbs of an S-shaped curve.

There can be little doubt that the synostoses, compressions, and sinuations afore described are, as Hyrtl surmised for the first-named, congenital in origin. As remarked at the outset (*ante*, p. 95), it is generally the custom to regard the causes producing congenital curvature of the spine as unknown. This may be so for lateral curvature, but concerning the vertical variety herein dealt with a consideration arises. The facts which I have recorded appear to me to point towards the conclusion that divergent as the conditions of sinuation and compression with or without co-ossification appear, they are in reality the opposite effects of one and the same disturbing influence; and, indeed, the indication of a sinuous arrangement in the compressed type (fig. 6) suggests that they are perhaps even more closely related. In both there results an approximation of the opposite spinal extremities, and, in relation to the vertebræ of each individually disturbed series, of the opposite faces of those which bound these. That the muscular rather than the skeletal system has been, as it were, at fault, is largely proved by the fact that there is no marked falling off in either the bulk or density of the latter where disturbance occurs; and the most logical conception of the determining cause seems to me that of an inequality of development, either in bulk or elasticity (and probably the latter), of certain muscles—those affected having either, as it were, lagged behind the skeleton or become fixed in a state of tonic contraction. If this be so, while approximation of the parts of the vertebral column stands out as the ultimate result of the disturbance, we may conveniently at least distinguish between the sinuous condition or approximation by *plecospondyly*[1] (figs. 1 and 3), and the compressed one or approximation by *sympiesospondyly*[2] (figs. 5 and 6).

The specimen last described is of interest in another connexion. Cunningham, in his monograph on the Sole (*loc. cit.* p. 39), gives 50 as the total number of vertebræ present, and points out that the first one "is rudimentary" and possessed of "two small dorsal processes which lie along the front edge of the base of the dorsal processes of the second vertebra, but do not unite to form a spine." There can be little doubt that these "dorsal processes" of the first vertebra are but a partially developed pair of neural arches—in the specimen under consideration they are reduced to absolute insignificance (fig. 4 *b*). This greater simplification of the first vertebra is the more interesting, as but 48 instead of 50 vertebræ are present, and as the well-defined characters which diagnose the 5th and 11th vertebræ of the normal spine are here realized by the 4th[3] and 10th.

P.S., March 1, 1894.—During the passage of these notes through the press, the College of Surgeons' Perch, No. 361 (*cf.* footnote, p. 96) has been dissected, thanks to the kindness of Prof. Stewart. The curvature of its backbone is, most interestingly, identical with that of figs. 3 *a* and 3 *b*, but of greater amplitude, as is expressed externally by a marked elevation of the trunk cephalad of the first dorsal fin. The vertebræ which mark its vertices number 7–8, 18, and 30. But 39 free vertebræ are present, and the displacement to the left side involves those numbering 20 to 35. Except for a feeble depression of the mid-dorsal region, the contour of the body is regular, and the arches, intermuscular bones, and associated parts are correspondingly modified.

[1] *πλέκειν*, to twist; *σπόνδυλος*, a vertebra.
[2] *συμπιέζειν*, to squeeze together.
[3] In this case on the left side only.



P Smit del et lith.

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TADPOLES OF XENOPUS LÆVIS.

EXPLANATION OF PLATE XII.

Reference letters:—*a.h.*, hæmal arch; *a.n.*, neural arch; *c.*, vertebral body; *sy.*, synostosis. The small numerals indicate the vertebræ (or, where two occur, the intervertebræ) which form the vertices of the curves.

Fig. 1 *a*. *Sole.* Vertebral column with five sinuations. From the left side. ⅔ nat. size.
1 *b*. *The same.* Lines of curvature.
2. *Sole.* Line of curvature of a backbone with three sinuations, and a feeble fourth one posteriorly. *R. C. S.* 364. ⅔ nat. size.
3 *a*. *Perch.* Line of curvature of the backbone (with three sinuations), with contour of the animal's body in relation to it. *R. C. S.* 364. ½ nat. size.
3 *b*. *The same.* Curvature, enlarged for comparison with 1*b* and 2. ⅔ nat. size.
4 *a*. *Sole.* Portion of a backbone with curvature involving vertebræ nos. 30 to 35, with marked angulation of those posterior to them. ⅔ nat. size.
4 *b*. *The same specimen.* First five vertebræ. × 2.
5. *Sole.* Portion of a vertebral column with vertebræ nos. 14 to 18 compressed and co-ossified. ⅔ nat. size.
6. *Sole.* Portion of a vertebral column, with vertebræ nos. 23 to 34 compressed. *R. C. S.* 500. ⅔ nat. size.

R. C. S. and the accompanying numbers refer to the 'Descriptive Catalogue of the Teratological Series in the Museum of the Royal College of Surgeons of England,' ed. 1893; and the specimens depicted in figs. 4 & 5 have been presented to that Institution by Prof. Sutton, but not yet catalogued.

2. Notes upon the Tadpole of *Xenopus lævis* (*Dactylethra capensis*). By Frank E. Beddard, M.A., F.R.S., Prosector to the Society.

[Received February 6, 1894.]

(Plate XIII.)

During the past summer one of the specimens of *Xenopus lævis* at the Society's Gardens deposited a quantity of ova, which duly hatched out. Ultimately a few frogs were bred from the tadpoles. I preserved a series of tadpoles from the newly-hatched larva onwards, partly in corrosive sublimate and partly with Perenyi's fluid; the following notes refer to my examination of those specimens. But, before proceeding to describe the external and a few of the internal characters of the tadpoles, I will briefly direct attention to previous work upon the subject.

The earliest description of the larva known to me is by the late Dr. J. E. Gray [1], a description which was subsequently [2] expanded and illustrated. The figure of the tadpole, showing the tentacles, does not show the dorsal fin, and is in other respects not good. In the definition of the tadpole (described as a distinct genus *Silurana*) we find the remark: "belly and underside of the

[1] "Notice of a new Genus (*Silurana*) of Frogs from West Africa," Ann. Mag. N. H. (3) xiv. p. 315.
[2] "Note on the Clawed Toads (*Dactylethra*) of Africa," P. Z. S. 1864, p. 458.

tail with a broad membranaceous fin continued to the end of the tail"—implying the absence of a dorsal fin. The next description and figures of the tadpole are to be found in the late Mr. W. K. Parker's memoir upon the Batrachian skull[1]. The dorsal and ventral aspects of the larva (*loc. cit.* pl. 56. figs. 1, 2) are very much better than the lateral view (*loc. cit.* pl. 56. fig. 3) which has been copied into the textbooks. This lateral view exaggerates the fish-like build of the larva, and even suggests armoured and extinct fishes. The dorsal and ventral fins, both of which are shown, are depicted as ceasing abruptly some way in front of the end of the tail, giving to it a totally undeserved "Chimæroid" look. There are, however, in the paper to which I refer some valuable notes upon the external characters of the tadpoles, as well as (of course) upon the skull-structure. The tentacles are correctly described, the absence of horny teeth noted, and the paired branchial orifices correctly located. On the other hand, as I shall show in the present paper, Prof. Parker was wrong in stating the absence of claspers beneath the chin.

Quite recently[2] Mr. Leslie has still further increased our knowledge of this Amphibian, though his notes with regard to the larva are only confirmatory of the results given in Parker's paper and are not wholly accurate, as I shall point out later, in the alleged absence of external gills.

The eggs laid in the Society's Gardens were deposited singly; no great masses of spawn like those of our Common Frog were found. Nevertheless I had a group of four or five adherent eggs brought to me. The eggs were laid some time in the evening of Saturday, May 27th, 1893; by Monday morning at 10 A.M. I had newly-hatched larvæ. The intervening Sunday prevented me from examining into the early stages of development. The rapidity with which the larvæ were hatched out is remarkable. At the Cape the breeding-season is early spring (August), but Mr. Leslie does not mention the period of time which elapses between the deposition of the ova and the appearance of tadpoles. The specimens which bred at the Gardens were some which Mr. Finn brought back with him from Zanzibar.

External Form and Colour.—The most remarkable point about these tadpoles is their extreme transparency. As will be seen from the accompanying drawings (Plate XIII.), the pigment is thinly scattered about, not obscuring the internal structure. The blood-vessels and even the nerves can be readily detected when the tadpole is examined alive. At first the tadpoles are in shape like those of the Common Frog; but on the third day, as Mr. Leslie correctly observes, the characteristic form of the more mature tadpole is acquired. The head and body become broader, and are not separated by a constriction as they are in the Common Frog. In

[1] "On the Structure and Development of the Skull in the Batrachia, Pt. II.," Phil. Trans. vol. 166 (1877), p. 625.

[2] "Notes on the Habits and Oviposition of *Xenopus lævis*," P. Z. S. 1890, p. 69.

the latter animal this constriction is due to a bulging of the body in the region of the pronephros. This bulging is less marked in the tadpoles of *Xenopus*. The dorsal fin commences just before the median occipital elevation begins to slope away posteriorly; the ventral fin commences just in front of the accurately median anus. The "abdomen" has a metallic glitter, and becomes much more swollen and relatively shorter in the later stages. The fins are continuous to the very end of the tail; there is no "Chimæroid lash" as depicted by Parker [1].

Habits.—The tadpoles generally rested in the water with the head downwards and the tail in constant wriggling motion. Whether this is connected with respiration or not I am unable to say. In any case I detected no special vascular supply or mechanism of any kind which might be related to such a function.

The food of the tadpoles consisted entirely of Cyprids, with which the tank, where they were housed, swarmed. Their intestines were invariably full of these Crustaceans and of nothing else. In spite of their purely carnivorous diet, the intestine was just as much coiled as in the common tadpole. The carnivorous diet, it should be remarked, was adopted from choice and not from necessity. There was plenty of water-weed upon which they could have fed. It is generally stated that the tadpole of the Common Frog is a vegetarian. It will, however, eat animal food, such as the dead bodies of its companions; it can also be compelled to take to a purely carnivorous regimen.

The following is a brief statement of the measurements and general characters of tadpoles at various stages.

Stage I.

Four specimens of the first stage were preserved in Perenyi fluid at 10 A.M. on May 29, *i. e.* 12 to 15 hours after hatching.

The total length of the tadpoles is after preservation 5 millim. Corresponding to tadpoles of same lengths figured by Marshall and Bles.

Stage II.

Preserved at 12 midday on May 30. Three individuals as nearly as possible of the same length, *i. e.* 7 millim. Corresponding more or less to 9 millim. in tadpole figured by Marshall and Bles. The relative proportions of body to tail are 2 : 3.

Stage III.

Preserved on June 1st. Length 8 millim. The form of the "adult" tadpole fully established. Length of body to that of tail as 3 : 5 [2].

[1] The appearance occurs, however, in spirit-specimens, owing to the clinging of the membranous fins to the solid part of the tail.

[2] The measurement of the body is taken to end of swollen abdomen, not to anus.

After this the tadpoles show a progressive and rapid increase in length. One of June 2nd was 10 millim., of June 5, 13 millim. A tadpole with fully developed hind limbs was 52 millim. long. A tailed frog (August 18) only 44 millim. The mature tadpole represented in the drawing (Plate XIII. fig. 4) is rather longer; it was not killed.

The *sucker* has been stated to be absent in *Xenopus*. This is not the case; I found it not only in the youngest stages, but in larvæ of 14 millim. in length; it gradually disappears, however, as the tadpole grows. An interesting point about the ventral sucker in this Amphibian is that it is a single structure apparently from the very first. It is certainly median and unpaired in the very youngest larvæ, which were 5 millim. in length. In larvæ of 7 millim. in length the chin sucker is exceedingly obvious, with a raised circular rim of a brown colour. The *circular* outline of the sucker in *Xenopus* contrasts with the *horseshoe-shaped* outline in the young tadpole of the Common Frog at the period when the two suckers have become fused. The coexistence of the suckers and the tentacles would seem to entirely disprove any possible homology between the two structures. In the youngest embryo at my disposal the sucker in transverse section occupied the whole of the ventral surface of the head, extending back to the level of the eyes. It is composed, as in *Rana*, of closely set elongated cells of a brownish colour. The cells converge upon the surface, so that in transverse sections through the head the cells are seen to be cut transversely and posteriorly, and to be covered by a layer of non-modified epidermis. The surface of the sucker at the centre is quite flat, and it stands out conspicuously beyond the surrounding integument. The cells of the sucker clearly belong to the outer of the two layers of the epiblast, into which they pass without any abrupt demarcation. In later stages the cells of the sucker get less and less unlike those of the surrounding integument. Prof. Parker's failure to find the sucker was due to the fact that his tadpoles were too old. I imagine that in tadpoles of such an age as those which he figures there would not be the least trace of these structures. It is curious, however, that Leslie makes no mention of them. He appears to have examined tadpoles of all ages, and in the youngest stages the sucker could hardly be missed if the tadpoles were examined with a hand lens.

Tentacles.—As is well known, this frog has a pair of long tentacles, which have been compared to those of a Siluroid fish [1]. These spring from the angles of the jaw just above the mouth. They get longer as the larva increases in size. More than once I have observed the tentacle of one side to be bifid. The earliest appearance of the tentacles is in the form of a little process of the integument as yet unconnected with the skull. I found the tentacles in this condition in two tadpoles preserved on June 2nd. In younger tadpoles than this I did not succeed in discovering any

[1] Perhaps better to the "nasal barbels" of *Myxine* and *Bdellostoma*.

trace of the tentacles. The tentacles in these tadpoles are in the form of a small process of the body connected with it by a narrower stalk; it is covered with a layer of columnar epidermis, and the interior is filled with a mass of dense tissue. It shows no resemblance to the sucker in its minute structure. A narrow rod of cartilage runs towards it from the ethmoid just above the joint where Meckel's cartilage articulates, but does not reach it. A slip of muscle is attached to the base of the rudimentary tentacle.

In a full-grown or nearly full-grown tadpole such as that displayed in the accompanying coloured drawing (Plate XIII. fig. 4) the tentacles are of considerable length, with a slender bar of cartilage running right along them as is figured by Parker (*loc. cit.* pl. lvii. figs. 1, 2, &c.). They are inserted so exactly at the angle of the mouth that they are deeply grooved by it. During life a blood-stream can be observed to pass along the tentacles. The histological structure is not in any way remarkable. Beneath the epidermis is a certain amount of pigment. The interior of the tentacle is taken up by a network of connective tissue. On that side furthest away from the body are two blood-channels lying side by side; the axis of cartilage is small relatively to the diameter of the tentacle. Mr. Boulenger, in a footnote appended to Mr. Leslie's paper quoted above, compares the tentacles to the "balancers" of *Triton* and *Amblystoma.* This can hardly be, if the latter are, as Mr. Orr states [1], the homologues of the external gills belonging to the mandibular arch.

Mouth-cavity and Pharynx.—In the newly-hatched tadpole (May 29) the mouth is only a depression not communicating with the gut; there are no gill-slits and no skull. On the following day the mouth was established. The most important fact with regard to the mouth-cavity has already been established by Parker and Leslie; that is, of course, the entire absence of the horny larval teeth. To confirm the absence of these characteristic structures by microscopical sections is not, perhaps, an altogether unnecessary piece of work. At no stage in the development of the tadpole of this frog did I succeed in discovering the least trace of the structures in question.

In tadpoles of May 31 some of the characteristic features of the mouth-cavity and pharynx are already obvious.

Just behind Meckel's cartilage is a deep recess of the mouth-cavity ventral in position; laterally this becomes a narrow slit, close to the cartilage, and appears to be the first visceral cleft, though I have not found any connection with the exterior. It differs from the succeeding visceral clefts in being directed more forwards, their inclination being at right angles with the longitudinal axis or oblique in the opposite direction. The first branchial cleft lying behind the hyoid arch is deep and narrow. It is at right angles to the longitudinal axis, whereas the succeeding

[1] "Notes on the Development of Amphibians, &c.," Q. J. M. S. 1889, p. 295.

clefts are slightly oblique. The epithelium which lines it differs on the anterior and posterior faces of the cleft. Anteriorly the epithelium, like that of the buccal cavity, is formed of low cells; posteriorly it is formed of tall columnar cells. These cells are continuous with the ventral epithelium of the pharynx, which has this character; the dorsal epithelium being low. This pharyngeal tract of columnar epithelium extends back over the whole of the branchial region, but suddenly stops short a little way in front of the origin of the lungs. This fact is perhaps incidentally of some little importance in view of the homology between gill-slits and lungs which was once urged. Had this modified tract of pharyngeal epithelium extended to the lung and into it, as into the hyoid and branchial clefts, the question might have been considered anew. It will be noted that the hyoid cleft differs much from the branchial clefts which follow in that the modified pharyngeal epithelium only lines its posterior surface. This cleft does not open on to the exterior.

In tadpoles of June 2nd (cut longitudinally and horizontally), in which the branchial basket was well developed with its vascular tufts, the hyoid cleft showed no traces of being a respiratory cleft and did not open on to the exterior either independently or by way of the other branchial cleft.

In a tadpole of June 5th, the opening of the hyoid cleft was effected. It has the form of a comparatively narrow tube, which, curving round shortly after its origin from the pharynx, opens into the first branchial cleft a long way from the opening of the latter on to the exterior.

Internal Gills.—The branchial arches, as in other Amphibia, fuse to form a basket-work, from the bars of which run cartilaginous processes which become tufted and form the so-called filtering apparatus. I observed the first traces of this filtering apparatus in tadpoles of May 31. These structures become later very vascular, and they must be respiratory in function, since no other internal gills are developed. In the Common Frog the tadpoles possess not only these "filters" but tufted internal gills. Messrs. Marshall and Bles [1], while admitting the vascularity of the filters, consider that, "as the blood is returned from them to the somatic veins, it is probable that they are not actively respiratory." They clearly must be in *Xenopus*, as there are no other gills.

External Gills.—As has been already mentioned, the tadpole of *Xenopus* is said by Mr. Leslie to possess no external gills. This statement is not quite accurate, though undoubtedly complex arborescent gills like those of *Rana* are not to be discovered. Messrs. Marshall and Bles have emphasized the fact, which has been rather slurred over, that the external and internal gills form a continuous series of structures. In 4–5 millim. long tadpoles of *Rana* "two pairs of external gills are present as backwardly-

[1] "The Development of the Blood-vessels in the Frog," Stud. Biol. Lab. Owens Coll. ii. 1890.

directed processes from the first and second branchial arches; they are somewhat conical in shape, with rounded or very slightly notched hinder borders." This description applies in the main to tadpoles of *Xenopus* of May 31st. The opercular fold is then only commencing to grow, and processes from the three first branchial arches just project beyond the line of the body. In the lax tissue lying in the interior of these processes is a capillary vessel derived from the vascular arch. The processes, however, are hardly conical in form; they have a long base of attachment, and are indeed rather to be described as lamellæ than processes.

Pronephros.—I carefully investigated the pronephros, but with entirely negative results so far as the discovery of anything of novelty is concerned. It is precisely like that of *Rana*, and opens into the body-cavity by three funnels opposite to its glomerulus.

Vascular System.—Messrs. Marshall and Bles have described with such minuteness the development of the heart and arterial system in *Rana temporaria* that a comparison with the corresponding stages of *Xenopus* becomes easy. It is very remarkable, as they point out, that the condition of the vascular arches should differ so much from that of the closely-allied *Rana esculenta*. In the latter, according to Maurer (quoted by Messrs. Marshall and Bles), the afferent and efferent branchial vessels are continuous with each other, forming complete arches. In one specimen of *Rana temporaria* the same continuity was noted, but as a rule the communication between afferent and efferent sections of the aortic arches was indirect through the branchial capillaries. In view of this difference between two species of one genus, the fact that *Xenopus* agrees with *Rana esculenta* is of less interest. In *Xenopus* it is quite easy to trace the four aortic arches from the heart to the dorsal aortæ.

The truncus arteriosus first divides into two branches (on each side); the posterior of these again divides into two, and a little later the vessel which is now the hindermost itself divides into two trunks; thus the four afferent branchial vessels arise. Messrs. Marshall and Bles figure (*loc. cit.* pl. xiv. fig. 6, A H) a short diverticulum of the truncus arteriosus lying in front of the fully-developed first branchial arch in tadpoles of 5 millim.; this they consider to be referable to the hyoid arch. It disappears soon. I find an entirely similar diverticulum of the first arch in *Xenopus* in a tadpole of 7 millim.; it was present on both sides of the body. In tadpoles of June 2nd there were only three vascular arches. The fourth arch, arising from the third, went straight to the lung.

EXPLANATION OF PLATE XIII.

Fig. 1. Tadpole of *Xenopus lævis* of June 5th.
Figs. 2, 3. Dorsal and ventral views of an older tadpole.
Figs. 4, 5. Lateral and dorsal views of a full-sized tadpole.

3. On some Remains of *Æpyornis* in the British Museum (Nat. Hist.). By Chas. W. Andrews, B.Sc., F.Z.S. (Assistant in the Geological Department).

[Received February 3, 1894.]

(Plates XIV. & XV.)

During the last two years several collections of vertebrate remains from Madagascar have been received at the British Museum. These include, in addition to the bones about to be described, portions of the skeleton of *Megaladapis madagascariensis* (a large lemuroid animal recently described by Dr. C. I. Forsyth Major (8)), and bones of a smaller species of the same suborder; *Hippopotamus* (? two species, both of small size); *Potamochœrus*; *Bos* (two species or varieties); *Haliaëtus* (? *vociferoides*); *Crocodilus robustus*; and a large *Testudo*. The localities in which these specimens were collected are all either in the centre of the island or at various points along the south-west coast. It will be convenient for purposes of description to take the remains from these two districts separately, the more so as it may hereafter be shown that the deposits in which the bones occur are of slightly different age. The reason for supposing that this may be the case is, that the species of *Hippopotamus* and those of *Æpyornis* from the centre differ from those occurring on the coast.

Remains of Æpyornis *from Central Madagascar.*

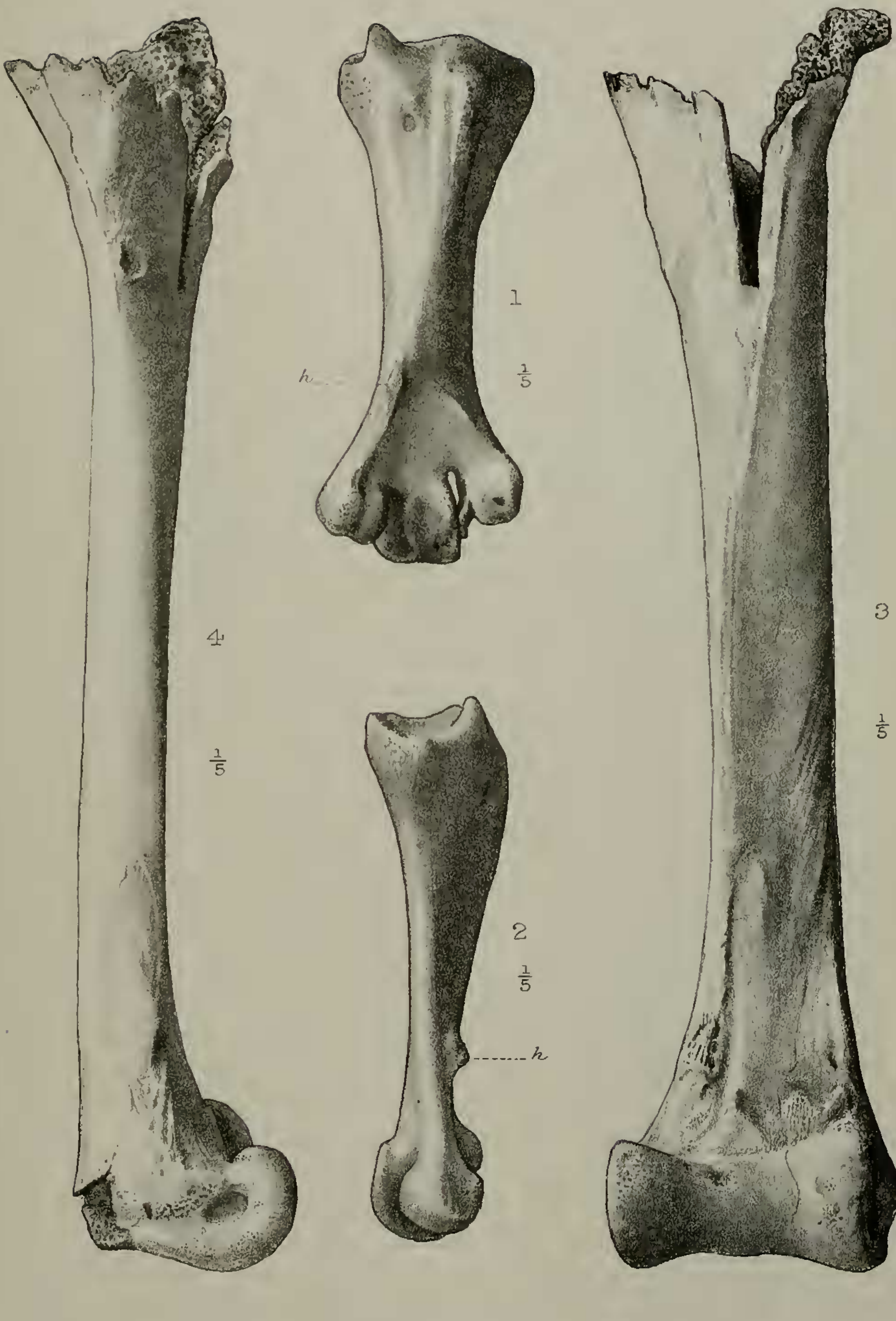
These are all from the neighbourhood of Sirabé, in the province of North Betsileo, situated on a plateau about 4000 to 5000 feet above the sea-level. In this district there are numerous hot springs, in the mud round which the bones are found. These are of a dark chocolate-brown colour, very heavy and brittle, and are impregnated with carbonate of lime, which forms crystalline masses in their cavities.

The portions of the skeleton represented are:—

(1) A complete right tarso-metatarsus.
(2) A nearly perfect right tibio-tarsus.
(3) Fragments of immature tibio-tarsi (of a large and small species).
(4) A first phalangeal of the inner toe of the left foot.

The *tarso-metatarsus* (Plate XIV. figs. 1 & 2) is very similar to that of *Æ. hildebrandti* figured by R. Burckhardt (2), but differs from it in size and in some points of structure. Its upper extremity is quite complete, so that it is possible for the first time to determine accurately the form of the talon and of the proximal articular surface.

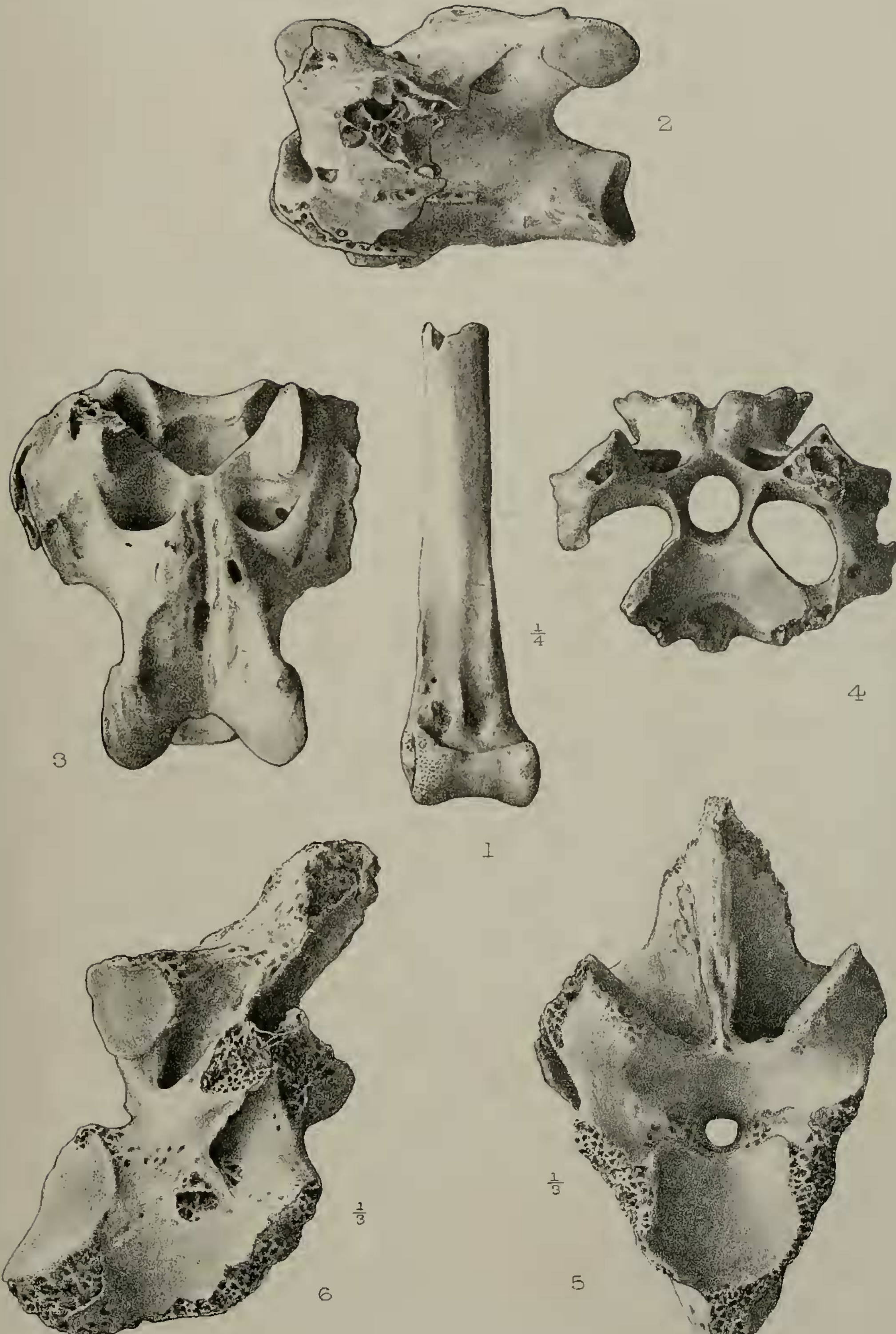
The dimensions of this bone are as follow; those of *Æ. maximus* and *Æ. hildebrandti* are given for comparison:—



E. C. & G. M. Woodward del. et lith.

West, Newman imp.

Fossil Bones of Æpyornis.



E.C. & G.M. Woodward del. et lith.

West, Newman imp.

Fossil Bones of Æpyornis.

	Æ., sp.	Æ. maximus.	Æ. hildebrandti.
	cm.	cm.	cm.
Length	31·6	37·0 (?)	27·5
Width of proximal end	11·5		9·5
Width of distal end	11·9	14·5	10·0
Width of shaft at narrowest point	5·4	8·0 (?)	4·5
Circumference of shaft at narrowest point	13·6	20·0	11·0
Width of middle trochlea	4·7	5·2	4·3

At the proximal end the inner glenoidal cavity is the deeper of the two; it is oval in outline, the long axis being antero-posterior, and its front and hind borders are produced upwards into blunt points, of which the hinder is much the higher. The outer glenoidal cavity is shallow, and slopes down at its antero-external edge, where it has no well-defined border. These two cavities are separated by a surface, plane behind and slightly concave from side to side in front; there is no distinct median groove such as is said to occur in *Æ. hildebrandti.* There is no trace of an intercondylar process. As in the other members of the genus hitherto described, the anterior surface of the shaft is deeply depressed in the middle line at the upper end, the depression dying away downwards, till a little above the trochleæ the bone is slightly convex from side to side. At the deepest part of the depression, about 5 cm. from the proximal end of the bone, the *foramina interossea* open. They are about 1 cm. apart and at the same level, thus differing from *Æ. hildebrandti*, where the outer is rather above the inner. Immediately below them there is a large rugose tuberosity for the insertion of the *tibialis anticus.* In the upper part of the outer surface is a rather broad groove passing obliquely from the anterior face to the posterior, where it dies away. The *talon* consists mainly of a broad blunt ridge, continuous with the upper end of the middle metatarsal and lying slightly to the outer side of the middle line. Internal to this is a broad, short, and very shallow groove, bounded internally by a low blunt tubercle lying immediately above the inner interosseous foramen.

The lower part of the posterior surface closely resembles in general appearance that of *Æ. hildebrandti*, but is remarkable from the fact that it shows a distinct trace of the presence of a hind toe. Although several authors state that *Æpyornis* possessed four toes, I am not aware that any trace of the presence of a hallux is to be found in any specimen described till now. On the postero-internal surface, about 9 cm. above the distal end of the inner trochlea, is a bony projection, measuring 3 cm. from above down, and 1 cm. from side to side; it rises to a height of about

1 cm., but the summit is broken away. This projection occupies just the position of attachment of the hallux in such birds as possess one, and it may represent the ligament by which the hind toe was attached ossified from age.

The trochleæ are large and are arranged along a slightly curved line. The middle one is broadest and projects beyond the others; its sides are deeply concave and its articular groove only very slightly oblique to the long axis of the bone. Of the other two, the inner is the smaller, but projects slightly beyond the outer. There are no projections at the lower end of the channel for the tendon of the adductor of the outer digit, such as are figured in the tarso-metatarsus of *Æ. hildebrandti*.

In both the present specimen and in that described by Burckhardt (2) the width of the distal end is greater, in proportion to the least circumference of the shaft, than it is in the tarso-metatarsi from the coast.

The *tibio-tarsus* is complete except the postcondylar processes, which are broken away. The bone on the whole resembles that of *Æ. hildebrandti*, but differs from it in size and in some other respects. The dimensions are:—

	Æ., sp.	*Æ. maximus.*	*Æ. hildebrandti.*
	cm.	cm.	cm.
Length	57·5	64·0	48·0
Width of distal end	10·0	13·5	8·2
Width of shaft at narrowest point	5·0		
Circumference of shaft at the same point	14·0	15·5	11·0

It will be seen from the above table that the tibio-tarsus, like the tarso-metatarsus, is intermediate in size between the corresponding bones of *Æ. maximus* and *Æ. hildebrandti*, and it is also rather longer in proportion to the tarso-metatarsus than is the case in *Æ. hildebrandti*. The antero-posterior flattening and the curvature of the shaft, which are characteristic of the genus, are well marked. The distal articulation fits exactly into the proximal one of the tarso-metatarsus above described, and there is no doubt that the two bones belong to the same species, if not to the same individual. The median ridge between the condyles figured in the tibio-tarsus of *Æ. hildebrandti* (2) is here wanting. The cnemial crest is moderately developed and rises a little above the proximal articular surface. On the upper outer surface of the ectocnemial crest is a foramen, probably pneumatic, the exact size of which cannot be determined, its edges being broken away owing to the thinness of the bone at that point.

It seems possible that these bones must be referred to *Æ. mulleri*, a species recently named by Milne-Edwards and Grandidier (4), but till a description and further measurements of the limb-bones are published it is impossible to be certain. The tibio-tarsus is, however, slightly smaller, aud the tarso-metatarsus slightly larger, than those of which the above-mentioned authors give the dimensions.

At first it appeared possible that these bones might be referred to *Æ. medius*, Milne-Edw. & Grand., since the femur on which that species is founded is, like the bones in question, intermediate in size between the femur ascribed to *Æ. maximus* and that of *Æ. hildebrandti*. Closer examination, however, renders it evident that the femur referred by Milne-Edwards and Grandidier to *Æ. maximus* is too large in proportion to the metatarsus on which that species must be regarded as based, and that it probably belongs to the larger form described below under the name *Æ. titan*. On the other hand, the type of *Æ. medius* agrees fairly well in relative size with the other limb-bones of *Æ. maximus* and may belong to that species. If this is the case, then the name *Æ. medius* becomes a synonym, and, as was remarked above, the remains here described must be referred to another species, possibly *Æ. mulleri*.

The phalangeal bone appears to be the first of the inner toe of the left foot. It measures 5·1 cm. long; 2·7 cm. from side to side and 2·4 cm. from above downwards at the proximal end; 2·4 cm. from side to side and 1·7 cm. from above downwards at the distal end. The proximal articular surface is slightly concave; its upper and outer borders are convex, the inner flat and the lower concave. It is more compressed from above downwards than the corresponding bone of *Dinornis*; and its distal articular surface, the groove of which does not extend on to the dorsal surface, is rather wider in proportion to the length. The shortest vertical diameter is 1·1 cm.

Remains of Æpyornis *from the South-west Coast.*

The chief localities in which these were collected are Itampulu-Vé, near Murderers' Bay, and Amboulisatra.

All the bones present a very fresh appearance, and some have evidently been rolled on the beach. At least three species are represented, ranging in size from a form much larger than *Æ. maximus* to one which is probably identical with the *Æ. modestus* or the *Müllerornis agilis* of Milne-Edwards and Grandidier (4). The specimens include more or less perfect femora, tibio-tarsi, tarso-metatarsi, a fibula, several vertebræ, and a fragment of a pelvis.

In the collection from Itampulu-Vé occur some tibio-tarsi and femora of gigantic proportions; some of these have already been briefly noticed in the 'Geological Magazine,' January 1894, where they are referred to a new species, *Æpyornis titan*.

There are two specimens of the tibio-tarsus, right and left

(Plate XIV. figs. 3 & 4), both unfortunately incomplete at the upper end. The dimensions of these bones are :—

	Æ. titan.	*Æ. maximus.*	*Æ. hildebrandti.*
	cm.	cm.	cm.
Length	80·0	64·0	48·5
Width of distal end	17·0	13·5	8·2
Width of shaft at narrowest point	7·5		
Circumference of shaft at narrowest point	20·7	15·5	11·0
Shortest antero-posterior diameter	4·5		

The shaft is slightly curved, the inner border being concave. The flattening of the lower part of the anterior face, characteristic of the genus, is here more strongly marked than in the other species, and extends rather farther up the shaft. This flat surface is bounded on either side by a ridge, that on the inner side being the stronger; these sharply separate the anterior from the lateral surfaces, which with the posterior form a continuous curve from side to side, rather flattened behind, especially towards the lower end of the bone. The lateral surfaces are also flattened and rough in the same region. A *linea aspera* runs obliquely across the upper part of the anterior face from the procnemial crest to the inner border, which it reaches about 32 cm. above the lower end of the bone. In the other species of *Æpyornis* of which the tibio-tarsus is known, as well as in *Dinornis*, this ridge takes a more longitudinal course and only reaches the inner border a little above the condyles. Immediately above the latter is a short ridge running up the face of the bone and having at its lower end a rugose tubercle. Between this ridge and the inner border is the groove for the extensor tendons of the digits, deep at its lower end and dying away as it is traced upwards. As in the other species there is no ossified extensor bridge. About 2·5 cm. above the outer condyle is a large foramen for the passage of a blood-vessel into the bone.

The condyles have the form characteristic of the genus. The inner is the larger and projects more forward. The intercondylar surface is only slightly depressed and, though faintly convex from side to side, does not form a distinct ridge between the condyles such as is figured by Burckhardt in *Æ. hildebrandti*. The lateral surfaces of the condyles have very deep pits for the insertion of ligaments, that in the outer being 2·5 cm. deep. Behind these pits are large rugose tuberosities. The surface for the fibula closely resembles that of *Æ. maximus*.

The wall of the bone is very hard and compact, and is about

1 cm. thick in the middle of the shaft, where the spongy bone is wanting; above and below this point the wall becomes thinner and the bony network more developed.

A left *fibula*, broken at the lower end, probably belongs to the same species. It is compressed from side to side to a rather greater extent than the fibula of *Dinornis*, and consequently its surface for articulation with the femur is narrower. The tuberosity for the insertion of the *biceps cruris* is very strongly developed, and the distance from it to the upper end of the bone is 19 cm. The greatest antero-posterior width of the upper end is 7·5 cm.; the width of the articular surface from side to side is 2·7 cm.

A very imperfect proximal end of a left *tarso-metatarsus*, from the same locality, measures 17·5 cm. across and probably belongs to *Æ. titan.*

Among the *femora* that are provisionally referred to the same species, there is one (figs. 1 & 2, *a*, pp. 114, 115) from the left side nearly complete, wanting only the upper end of the trochanter and some portion of the condyles. Its dimensions are :—

	Æ. titan.	*Æ. maximus.*	*Æ. hildebrandti.*
	cm.	cm.	cm.
Approximate length..............	41·0	32·0 (? true length)	
Circumference of the shaft at the narrowest part	27·3	27·0	15·8
Width from side to side at the same point	9·2	9·1 [1]	5·0
Width of distal end (approximate)	21·0	19·0 (?)	10·0

The neck is short and thick, measuring 23 cm. in circumference; its anterior surface is very rugose. The trochanter is very massive; its smooth upper surface for articulation with the anti-trochanter of the ilium slopes steeply upwards and outwards from the neck, widening rapidly, and it must have risen considerably above the head, but the upper end being abraded it cannot be determined to what extent this was the case. The anterior surface of the trochanter does not appear to have projected forward so much as in *Dinornis*.

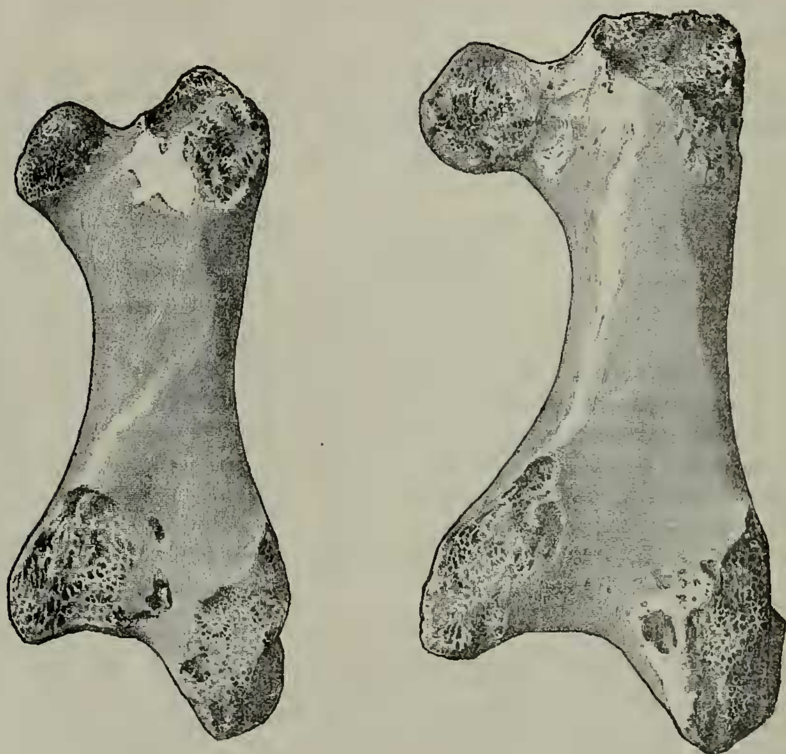
On the posterior surface near its junction with the neck is a large pneumatic foramen, the edge of which is unfortunately broken, so that its size cannot be accurately determined. This opens into a wide thin-walled passage, measuring 3 cm. from side

[1] This measurement is taken from a cast in the British Museum.

to side and 1·5 cm. from before backwards, which passes down to about the middle of the shaft, where it terminates in the bony reticulum with which the bone is nearly filled. This pneumatic foramen, though present in most Ratites, is entirely wanting in *Dinornis* and *Apteryx*.

The shaft is narrowest about 12 cm. below the upper surface of the neck, where it is oval in section, the short diameter being antero-posterior. Below this point the flattening increases, and just above the condyles the anterior surface is only slightly convex from side to side.

Fig. 1.



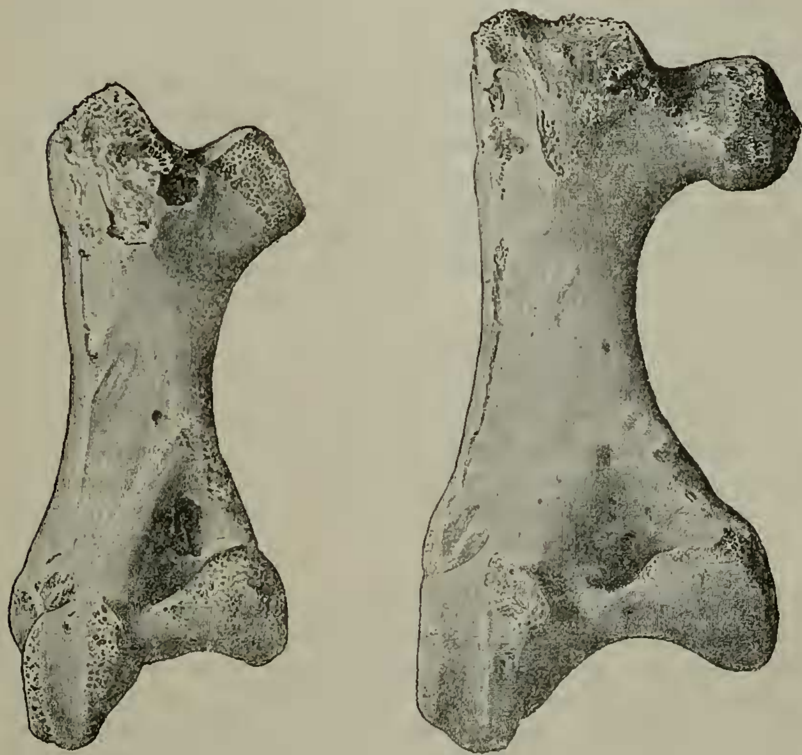
b a

a. Left femur of *Æpyornis titan* (?), from front.
b. ,, ,, *Æpyornis* (?), from front.
Both $\frac{1}{3}$ nat. size.

The popliteal fossa is large and triangular in shape, its lower border being formed by the inner condyle and a strongly projecting rounded intercondylar ridge, the inner by a rough ridge terminating above in a blunt tubercle, while its outer boundary is not well defined, since the floor of the fossa slopes gently up, passing imperceptibly into the posterior face of the shaft. Into the popliteal fossa several pneumatic foramina open, the largest measuring 7 by 5 mm.

The condyles, which are very massive, are broken away in front; the outer projects considerably below the inner. Their lateral surfaces are concave and rough. The intercondylar fossa is scarcely perceptible and the surface for the fibula is narrow.

Fig. 2.



b a

a. Left femur of *Æpyornis titan* (?), from behind.
b. „ „ *Æpyornis* (?), from behind.
Both $\frac{1}{3}$ nat. size.

In some of the broken femora referred to *Æ. titan* the internal structure can be well seen. The wall of the bone is very compact and hard, and in the middle of the shaft it is 7 mm. thick. The central cavity is very small, the bone being almost entirely filled with a complex bony reticulum, the meshes of which are for the most part more or less rectangular. If we compare this structure with that found in *Struthio* and *Dinornis*, we find in each case great variations, but of a different kind.

In *Struthio* the central cavity of the femur is large and smooth-walled for about 6 cm. in the middle of the shaft, the cellular bone being there absent. Above and below this it increases in quantity, narrowing the cavity of the shaft and completely filling the ends of the bone. As in *Æpyornis* there is a large pneumatic foramen on the posterior surface about the level of the neck, and also several smaller ones opening into the popliteal fossa.

In the larger species of *Dinornis* the central cavity of the shaft is small. This, however, is not owing to the development of the bony reticulum, but to the great thickness of the walls, which appear to consist of an outer hard compact layer and an inner much thicker layer of soft bone, the innermost portion of which alone is honeycombed so as to form the bony network. The solid wall of the shaft of a femur 31 cm. long measures 2 cm. in thickness. As in *Apteryx* there are no pneumatic foramina, and the cavity of the bone must have been filled during life with marrow.

In the same collection there is another nearly complete femur (figs. 1 & 2, *b*), rather smaller than the one just described, and differing from it so much that it will probably be found necessary to refer it to a different genus.

Its measurements are :—

	cm.
Approximate length	38·0
Diameter of shaft from side to side at narrowest point....................................	8·5
Circumference at the same point	24·7
Approximate width of distal end	16·5
Circumference of neck	20·0

It is therefore evident that the proportions of this bone are different from those of the femur referred to *Æ. titan*. Thus, if the length be taken as 100 in the two cases, then in the present specimen the width of the distal end will be approximately 43·4, while in *Æ. titan* it will be 51·2. Similarly, if the least circumference of the shaft be taken as 100, then the proportionate width of the distal ends will be 66·8 and 76·9 respectively.

The chief points other than size in which this femur differs from that referred above to *Æ. titan* are :—

(1) The trochanter is much less massive.
(2) The head and neck, instead of projecting at right angles to the long axis of the bone, are turned somewhat upwards.
(3) The middle of the shaft is roughly quadrate in section, owing to the flattening of the outer, inner, and posterior surfaces.
(4) As was shown above, the distal extremity is proportionately less massive.
(5) The popliteal fossa has a high outer border, formed by a rounded ridge running fron the outer condyle to the tuberosity at the upper angle of the fossa.

(6) The rotular surface is very broad and flat, and makes an angle of about 90° with the inferior intercondylar surface instead of passing into it by a gentle curve.

The intercondylar fossa is slightly marked. The upper pneumatic foramen is present as in *Æ. titan*, and, the floor of the popliteal fossa being broken away, it can be seen that the inferior foramina opened into a large air-chamber. There is also a pneumatic foramen about the middle of the rotular surface, which is not found in *Æ. titan*. The nutritive foramen on the posterior surface of the shaft is single, in the femur above referred to *Æ. titan* there are two; but since this is not the case in some of the more imperfect femora belonging to the same species, it is merely an individual variation.

This femur may possibly belong to *Æ. maximus* or to either of the recently named species, *Æ. cursor* and *Æ. lentus* (4). In any case, as was remarked above, the differences between it and the femur referred to *Æ. titan* appear to be of generic value; and if this be so, then there is evidence of the existence of a third genus, since the recently named *Mullerornis* seems to include only slender forms of comparatively small size.

Until, however, it is definitely known whether the femur of the type species of *Æpyornis* resembles that of *Æ. titan* or the one just described it would be imprudent to establish a new generic name. The evidence necessary for the decision of this question is probably in the hands of MM. Milne-Edwards and Grandidier, and a full description and figures of the magnificent collection recently briefly noticed by them, especially of the skulls and sterna, will be anxiously awaited.

From the same locality there are several fragments, including the distal ends of three tibio-tarsi, which appear to belong to *Æ. maximus*. A right tarso-metatarsus with the upper end above the interosseous foramina broken away may also be provisionally referred to the same species; it is, however, slightly smaller, measuring 6·3 cm. across the narrowest part of the shaft in comparison with 6·9 cm. in *Æ. maximus*. If *Æ. medius* should be found to be a distinct species, this bone may possibly belong to it. In form it closely resembles the tarso-metatarsus of *Æ. maximus* figured by Milne-Edwards and Grandidier (3), and, like it, differs from the tarso-metatarsi from the centre of the island mainly in the fact that the shaft contracts from side to side above the trochleæ more gradually and to a slightly less extent [1].

From Itampulu-Vé and Amboulisatra are several portions of the skeleton of a much smaller form, possibly that recently named *Mullerornis agilis* by Milne-Edwards and Grandidier (4). These include the distal ends of several tibio-tarsi (Plate XV. fig. 1), which closely resemble the same bone of the larger forms in their

[1] This specimen may belong to the species recently named *Æ. cursor* by Milne-Edwards and Grandidier.

articular region, though the shaft presents considerable differences. These are :—

(1) The flattening of the lower part of the anterior surface is less marked.
(2) Above the flattened region the shaft contracts somewhat suddenly in width, becoming at the same time oval in section.
(3) The groove for the extensor tendons of the digits is somewhat deeper than in *Æ. maximus*, the ridge on its outer side being more strongly developed, while its inner border rises into an elongated blunt tuberosity, 2·5 cm. in length from above downwards, its lower end being about 3 cm. above the inner condyle.
(4) Judging from various fragments, the whole tibio-tarsus appears to have been of much more slender proportions than in the larger forms ; it probably measured about 50 cm. in length [1], or rather more than the tibio-tarsus of *Æ. hildebrandti*, the other dimensions of which are considerably greater than the corresponding ones of this bone.

The other chief measurements are :—

	cm.
Width of distal end	7·5
Diameter of shaft from side to side at narrowest point	3·2
Circumference at the same point	8·7

The most nearly complete specimen of the smaller femora unfortunately wants the entire trochanter and inner condyle, while the head and outer condyle are much abraded. From the upper surface of the head to the lower end of the outer condyle, measured along a line parallel to the long axis of the bone, the length is 24·5 cm. ; a similar measurement of the femur of *Æ. titan* gives 40 cm. The circumference of the shaft at the narrowest point is 13 cm., while that of the femur on which *Æ. modestus* is founded is given by Milne-Edwards as 12 cm. ; two other femora in this collection measure 11·5 and 12 cm.

The bone is much compressed from before backwards, and the upper portion of the anterior face is very flat. The popliteal fossa is shallow and its borders less strongly defined than in the larger forms.

The wall of the bone is compact and thin, but, unlike the larger femora, the cavity is large, since the bony reticulum is little developed.

In the collection from Itampulu-Vé there are several nearly complete vertebræ belonging to a large and a small species. The smaller vertebræ include a nearly complete cervical, a cervico-dorsal, and two dorsals.

[1] The actual length of the tibia of *Mullerornis agilis* is 44 cm.

The cervical (Plate XV. figs. 2, 3, 4) is of the following dimensions:—

	cm.
Length of centrum	4·1
Width between anterior ends of pre-zygapophyses	2·5
Width between outer edges of post-zygapophyses	2·6
Diameter of neural canal	1·0
Longest diameter of anterior end of vertebrarterial canal	1·4

The centrum is much compressed from side to side in its middle portion, but widens out towards the ends. The articular surfaces are of the characteristic avian form; the anterior is wide from side to side and narrow from above downwards, owing to its upper and lower borders being deeply concave; the posterior is slightly wider than high and all its borders are concave, the lower deeply so. On the ventral surface of the centrum, about one third of its length from the anterior end, is a median hæmapophysis, the front of which rises steeply, while its hinder border passes by a more gradual slope into a median ridge which runs back for about 1·5 cm. in the middle ventral line. There is no pneumatic fossa in the side of the centrum.

The lateral portions of the neural arch are remarkably thin. The diapophyses and parapophyses are well developed, and, on the left side, the fused cervical rib is nearly complete, only its hinder portion being broken away. The vertebrarterial canal is very large, much larger, indeed, than the neural, a condition not occurring in the living Ratites or, to the same extent, in *Dinornis*. The interzygapophysial bar has behind and beneath it a pneumatic fossa, and above and in front of it on the dorsal surface, immediately behind the anterior zygapophyses, there is a still larger fossa into which several pneumatic foramina open. On the upper surface of the post-zygapophysis, near its outer hinder border, is a small tubercle (hyperapophysis), from which there runs forwards and inwards a ridge which increases in size as it goes; this does not meet its fellow of the opposite side to form a median neural spine, but is separated from it by a groove, which is shallow in front but deepens suddenly behind, forming a pit for the intervertebral ligament.

The cervico-dorsal vertebra differs from the one just described in possessing a broader and less compressed centrum, into the sides of which open a pair of large pneumatic fossæ. The arch also is more massive and the ridges running forward from the post-zygapophyses very much higher and broader; as in the cervical, however, they do not unite to form a median neural spine. The pneumatic fossæ of the arch closely resemble those of the cervical vertebræ. The parapophyses and diapophyses have smooth articular surfaces for the free rib.

The smaller dorsal vertebræ are very similar to the larger ones, and since the latter are the more complete they will be here described, though measurements of both will be given.

Of the two fairly complete large dorsals the one (Plate XV. figs. 5 & 6) which appears to be the anterior gives the following measurements:—

	cm.
Length of centrum	7·5
Approximate height from ventral surface to top of neural spine	22·0
Width of centrum in middle	5·0
Diameter of neural canal from side to side	1·5

The centrum, which is slightly compressed, is produced ventrally into a hæmapophysis, which has been mostly broken away. The anterior articular surface is broader than high, while the reverse is the case in the hinder. The neural arch is very massive, and its sides below and in front of the broken transverse process are excavated by a large fossa roughly pyramidal in form. The articular surface of the anterior zygapophyses is nearly circular, its diameter being about 4·2 cm.; in the posterior the surface is oval. The neural spine which slopes forward is very large and high; it is united with the post-zygapophyses and transverse processes by two pairs of thin vertical buttresses of bone, and with the anterior border of the arch by a median unpaired buttress; between these plates of bone there are deep pyramidal fossæ. The result of this arrangement is that, though the vertebræ are very large, they are at the same time extremely light. The transverse processes and the anterior lateral borders of the centrum being broken away, there is no trace of the articular surface for the ribs.

The other large dorsal appears to have been posterior to the one just described. Its centrum is less compressed than that of the latter, and, as far as can be seen, there was no hæmapophysis. Both the anterior and posterior articular surfaces of the centrum are about as broad as high. The articular surface of the post-zygapophyses are ovoid in shape and of great size, the long axis of that on the left side measuring 6·7 cm., though in this specimen that on the right side is somewhat smaller. The fossæ in the side and on the dorsal surface of the arch are much like those described above, but there is an additional median one between the post-zygapophyses, bounded in front by the neural spine and behind by the hinder border of the neural arch. The dimensions are:—

	cm.
Length of centrum	7·2
Width of centrum in middle	6·0
Height of centrum in middle	6·0

As in the last specimen the articular facets for the ribs are broken away.

As was mentioned above, the smaller dorsals closely resemble the larger in most respects; they differ, however, in the form of the anterior and posterior articular surfaces of the centrum. These are concave and convex from side to side respectively, as usual, but show scarcely any curvature from above downwards. There is, moreover, a lateral fossa in the centrum separated from that in the arch by a nearly horizontal plate of bone.

The specimen which agrees most closely with the first of the larger ones just described has a centrum measuring 4 cm. long, 3 cm. high, 2·5 wide in the middle.

Another specimen gives the following measurements:—

	cm.
Length of centrum	3·5
Height of centrum at hinder end	2·7
Width of centrum in middle	2·0

From the above descriptions it will be seen that the Æpyornithidæ must have included a large number of forms differing greatly in size and proportions; indeed, in a very recent paper (4) Milne-Edwards and Grandidier have given names to no less than seven new species, three of which are referred to a new genus, *Mullerornis*, and it seems probable, as was shown above, that a third genus at least will have to be established. It is to be hoped that the authors just mentioned have taken some particular bone as the type specimen of each species, and that names have not been given to miscellaneous collections of conjecturally associated bones. If it should unfortunately prove that this precaution has been neglected, then it seems probable that confusion in the nomenclature of the Æpyornithidæ will result.

It is greatly to be desired that collectors should, whenever possible, mark in some distinctive manner such bones as occur together and appear to have belonged to one individual[1]. But even when this is not done, it is still possible to avoid confusion to a large extent by applying specific names to some definite bone, preferably the metatarsus, as the type specimen of the species.

The Affinities of Æpyornis.

Concerning the affinities of *Æpyornis* the most divergent views have been held. Isidore Geoffroy in his original paper (6) referred it to the Brevipennes (Ratitæ), an opinion now universally accepted. Valenciennes (9) considered it to be a diving bird, related to the Auks and Penguins. Bianconi (1) in a long series of papers strove to show that *Æpyornis* was the "Roc" of Eastern fable, and that its nearest living relative is the Condor. Milne-Edwards and Grandidier (3) confirmed Geoffroy's original opinion and considered that *Casuarius* and *Dinornis* are the nearest allies. Von Haast (7), on the other hand, opposed this view and asserted that the resemblances with *Dinornis* are superficial. Recently this opinion has been endorsed by Fürbringer (5) and R. Burckhardt (2), both of whom, after an elaborate comparison of the Æpyornithidæ with the other Ratite families, come to the conclusion that such resemblances as exist between *Æpyornis* and *Dinornis* are merely the

[1] In the present instance this appears to have been out of the question, the bones occurring scattered at random.

result of convergence resulting from similar conditions of life, and that though the great massiveness of the skeleton (pachyostosis) is characteristic of both families, it is attained in quite a different manner in the two cases. This conclusion would certainly seem to be supported by the bones here described.

In the femora, for instance, apart from their great difference of form, the large upper pneumatic foramen, the numerous smaller ones opening into the popliteal fossa, and the great development of the bony reticulum are characters entirely wanting in *Dinornis*. Such points of structure as these appear to be of more importance in determining affinities than the mere external form of the bones, which may be supposed to vary more readily with changes in the conditions of life; for it is difficult to understand how such differences of structure could arise in two closely related forms, since the same end appears to be attained in the two cases in different ways. The conclusion to be drawn from this is that the divergence between the two families must have occurred before the characteristic pachyostosis had been acquired. In their recent paper (4) Milne-Edwards and Grandidier have given a brief description of the skull, which, as far as it goes, does not seem to afford much evidence in favour of the supposed close relationship with *Dinornis*; nevertheless, at the close of their communication the authors, as in their former paper, assert their belief that there is really such a relationship, and suggest the former existence of a southern land-connection to account for it. Perhaps when a complete description with figures of the skull, sternum, and pectoral girdle have been published, it may be possible to arrive at some definite conclusion concerning this interesting point.

List of papers referred to.

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3. Edwards, Alph. Milne-, et Alf. Grandidier.—"Nouvelles Observations sur les Caractères zoologiques et les Affinités naturelles de l'*Æpyornis* de Madagascar." Annales des Sciences naturelles (Zoologie), série 5, vol. xii. Paris, 1869.
4. Edwards, Alph. Milne-, et Alf. Grandidier.—"Observations sur l'*Æpyornis* de Madagascar." Comptes Rendus de l'Acad. d. Sci. t. cxviii. p. 122. Jan. 1894. Paris.
5. Fürbringer, Max.—Untersuchungen zur Morphologie und Systematik der Vögel. II. Allgemeiner Theil, pp. 1463–6. Amsterdam, 1888.
6. Geoffroy St.-Hilaire, Isidore.—"Note sur des ossements et des œufs trouvés à Madagascar dans des alluvions modernes, et provenant d'un Oiseau gigantesque." Comptes Rendus de l'Acad. d. Sci. t. xxxii. p. 101. Paris, 1851.

7. HAAST, JULIUS VON.—"Remarks on the Extinct Birds of New Zealand." The Ibis, 1874, p. 209.
8. MAJOR, C. I. FORSYTH.—"On *Megaladapis madagascariensis*." Proc. Roy. Soc. vol. liv. 1893, p. 176.
9. VALENCIENNES. Comptes Rendus de l'Acad. d. Sci. t. xxxix. p. 837. Paris, 1854.

EXPLANATION OF THE PLATES.

PLATE XIV.

Fig. 1. *Æpyornis mulleri* (?), Milne-Edw. & Grand. Right tarso-metatarsus from behind.
2. *Æpyornis mulleri* (?). Right tarso-metatarsus from inner side. *h*, Point of attachment of hallux.
3. *Æpyornis titan*. Left tibio-tarsus from front. (Type specimen.)
4. The same from inner side.

All the figures are one-fifth natural size.

PLATE XV.

Fig. 1. (?) *Mullerornis agilis*, Milne-Edw. & Grand. Distal portion of right tibio-tarsus from front. $\frac{1}{4}$ nat. size.
2. Cervical vertebra of a small species of *Æpyornis* (?) from left side. Nat size.
3. The same from above. Nat. size.
4. The same from front. Nat. size.
5. Dorsal vertebra of large species of *Æpyornis* from right side. $\frac{1}{3}$ nat. size.
6. The same from front. $\frac{1}{3}$ nat. size.

4. On the Bones of the Æpyornis, and on the Localities and Conditions in which they are found. By J. T. LAST.

[Received February 4, 1894.]

In response to the kind invitation of the Secretary of this Society, I beg leave to offer the following remarks on the bones of the fossil Æpyornis for their consideration. There may be much of what I shall say which will, perhaps, not be new to them, yet if it confirms that which was already known it will not be altogether useless.

I first arrived in Madagascar in the summer of 1889. I made Nossy-bé, an island on the N.W. coast, my head-quarters, and then slowly worked my way down to Nossy-vé, an island near the S.W. extremity of Madagascar. It was in the early spring of 1891 that I arrived at Nossy-vé, and I remained in the south and south central parts of Madagascar till September of 1893, and then I began to turn my face towards home. During the time I was in the south parts of Madagascar I had several opportunities of searching for remains of the Æpyornis. These I made use of with varied success, and though I may not have been so unfortunate as I had hoped, yet my efforts and the experience I gained gave me an insight of the bird's former habits, and the kind of places where its remains are likely to be found.

From what is already known, the Æpyornis may be considered as having had a range over the whole, or nearly the whole, of the southern half of Madagascar. This is proved by the fact that its remains have been found at Sira-bé, a place situated in about lat. 19° 50′ S. Twice I have known its bones to have been found near Mórondáva, a small town on the W. coast in about lat. 20° 20′ S. An egg was also found at Mánanjára on the east coast in about lat. 21° 10′ S. These discoveries are sufficient to prove that the bird occupied more or less the whole of the southern half of Madagascar.

I do not believe that the whole of this large tract of country was equally overrun by these birds, but rather that their numbers were much greater in the south and south-western parts than in the more northerly and eastern parts. This is shown, I think, by the fact that, excepting an egg found at Mánanjára, few or no remains have been found in south-east Madagascar, but that nearly all the remains that have been brought to light up to the present have been discovered in the south and south-western parts. That the birds were more plentiful in the south and south-west parts of the island may be inferred from the abundance of broken egg-shells which are to be found on the rocky sides of the range of hills on the S.W. coast, whereas I do not remember having heard or read that there were such broken egg-shells on the S.E. coast. All the unbroken eggs have, almost without exception, been found on the south or S.W. coast. About two years ago I heard of a specimen which was picked up floating about on the Mórondáva River, near its mouth; but this is the only instance, so far as I know, of one being found north of St. Augustin's Bay.

Regarding my own operations in searching after fossils, I think it will be better if, in the first place, I describe my work in the Mánansúa district of the Antinosi country, in south central Madagascar, about long. 45° E. and lat. 23° S. It was only after two or three unsuccessful attempts to enter the country that I was at last able to do so, through the friendship of Béfanátriki, one of the Antinosi kings, who being about to return to his own country permitted me to accompany him. The journey occupied us eight days. On arrival at the king's chief town I was given a house to use till I could make myself one more suitable. This building-work occupied me some time, and in going about with men to collect material I came across several places which appeared to me likely to be fossiliferous. On making inquiries of the natives, I was told that there were many bones, large and small, in the peaty flats where they make their rice-gardens, but they did not know to what animal the bones had belonged. After negotiating with the king for awhile, he allowed me to dig about on one of the uncultivated bogs alongside the Ifunsi River. The soil met with was black and clayey above, then we came to a layer of whitish marly soil, followed by a friable kind of light grey limestone, resting on fine-grained red sandstone. The fossils found were chiefly bones of Crocodiles, Hippopotami, broken tortoiseshells of more than one species, with a few fragments of Æpyornis-bones and a variety of vertebral bones, some of which must have belonged to other animals than those named above. All these were found between the grey marl and the limestone. The place abounds with fossils; but one would be led to judge that the creatures had not died where the fossil remains are now found, but rather that they had died at a distance, and that the bones, being set free by decomposition of the body, had been carried down to their present positions by heavy rainfalls or other means. If this was really the case, it would account for the jumbled-up manner in which the fossils are found, and would also give a reason why we did not find a skeleton intact.

For nearly a year I made Mánansúa my head-quarters, journeying into the country in different directions as opportunity occurred. By this means, and from native report, I was able to learn a great deal about the nature of the surrounding country. It seems, from what I saw, that a great deal of the country to the south and east of Mánansúa was formerly covered with a number of small lakes. These slowly became dry, from two causes—first by being gradually silted up from the surrounding higher ground, and also by the water, when the lakes were full, cutting its way out through the soft sandstone rocks, until a passage was formed which allowed the whole of it to escape. Crocodiles abounded in these lakes, as their descendants do in the lakes which remain. A small kind of Hippopotamus and a large Tortoise lived about the lakes and near country; these have left nothing but their fossilized bones to show that they once existed.

By talking with the king and people about these fossil remains, I learnt that they were in no way confined to the Mánansúa district, but were to be found all over the country to the N.E. along the Sakamare River—at Ilunti, more north, and beyond in the Bara country, still farther north. In times of peace the Antinosi and Bara tribes interchange visits. Some men who had been there were working for me, and told me they had seen the same kind of bones in the Bara country. The natives have no knowledge of the creatures of which these fossils are the remains, and if asked, generally say they are the bones of the Pang'ani, a mythical creature, in whose existence most of the Malagasy tribes firmly believe.

From Béfatúri (an Antinosi king, living at Kiliarivo, to the N.W., and whom I met several times) I learnt that there are several bogs in his district, with fossil bones in them, and judging from the manner in which he described some of the long bones, I think it quite possible that some remains of the Æpyornis have been turned out by the natives whilst working in their gardens. He much wanted me to go and visit him at his town, but I could not get the opportunity.

Passing thence to the valley of the Táheza River one comes to another piece of country where there are a number of silted-up lakes, now dry and used as rice-gardens. Here again, undoubtedly,